

BREEDING BIOLOGY AND DIET OF THE FERRUGINOUS HAWK IN SOUTH DAKOTA

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The Ferruginous Hawk (*Buteo regalis*) is the largest North American buteo. It occurs throughout most of the western United States and breeds from Alberta to western Texas and from Washington to Arizona. In this study we investigated the breeding biology of the Ferruginous Hawks in northwest South Dakota, complimenting earlier studies by Weston (1969) in Utah, Olendorff (1973) in Colorado, Howard (1975) in Utah and Idaho, and Lokemoen and Duebbert (1976) in north-central South Dakota.

STUDY AREA AND METHODS

The study area encompassed about 7000 km² in northwest South Dakota, including all of Harding County. The area is semi-arid and has a mid-continental climate with long, cold winters and short, warm summers (Spuhler et al. 1971).

Eighty-five percent of Harding County is rangeland dominated by western wheatgrass (*Agropyron smithii*) and needle grass (*Stipa comata*). Sagebrush (*Artemesia* spp.) occurs throughout the area and is widespread in the western third of the county. Small grain crops compose 9% of the area, pastureland and tame hay 3% and woodland 3%. Elevated table lands are dominated by ponderosa pine (*Pinus ponderosa*) savannah, whereas green ash (*Fraxinus pennsylvanicus*), willow (*Salix* spp.) and Siberian elm (*Ulmus pumila*) predominate in riparian areas and ravines.

Two or more biologists conducted a daily census of birds on the study area in 1976 and 1977; Ferruginous Hawk studies began the day the first hawk was sighted. Active nests were located either during aerial surveys at altitudes of 150-175 m, or by ground searches from roads. To reduce the possibility of nest abandonment, nests were approached only after at least one egg hatched. Nests were visited once every 2 days to weigh fledglings and collect pellets. We estimated minimum clutch-size from the number of young and the number of remaining unhatched eggs. A nesting attempt was defined as the presence of at least one egg; a successful nest was one from which one or more young fledged. Density of breeding pairs was determined by dividing the number of pairs present by the total area. Nest-sites were classified according to land surface features, vegetative cover and height.

Pellets and prey remains found at the nest-sites were collected. Pellets were collected from 18 nests in 1976 and 17 nests in 1977. Most pellets obtained were from young birds but we felt that the pellets also reflected the adult diet. Percentage of occurrence was calculated for all prey species.

All nestlings were banded with U.S. Fish and Wildlife Service lock-on leg bands. In 1977, six fledglings were fitted with 25 g radio transmitters attached with temporary backpack harnesses (Dunstan 1972). These birds were located by triangulation from two tower receivers within range of each nest; 2147 triangulation locations were plotted. Maximum area was determined by eliminating the 5% of the points that were farthest from the nest and connecting the new outermost points (Odum and Kuenzler 1955).

RESULTS AND DISCUSSION

Nesting density.—In 1976, 24 pairs of Ferruginous Hawks were observed in the study area; 17 pairs and two unpaired adults were present in 1977. Average distance between active nests was 7.2 km in 1976 and 6.4 km in 1977. Density of breeding pairs was one pair per 292 km² in 1976 and one pair per 412 km² in 1977.

During the 1976 breeding season six pairs occupying territories in early April did not nest. Three of these pairs contained one bird in immature plumage and one bird in adult plumage. Ferruginous Hawks do not breed until their third or fourth year (Brown and Amadon 1968:629). All pairs observed in 1977 nested.

The density of Ferruginous Hawks observed in this study area was lower than that found by other investigators. Lokemoen and Duebbert (1976) reported one pair of Ferruginous Hawks per 17.4 km² in north-central South Dakota, and Weston (1969) found one pair per 39.9 km² in Utah. Weston observed one pair for each 18.1 km² on a small area within his 1969 study area. Platt (1971) reported a density of one pair per 116 km² in Curlew Valley, Utah, and Olendorff (1973) found one pair per 99.9 km² on a 2598 km² study area in Colorado.

Breeding season chronology.—Ferruginous Hawks were first observed on the study area on 24 March 1976 and 27 March 1977; these dates were verified with data from the daily, year-round avian census conducted on the study area. Courtship and nesting activities began during the first week of April. Data were obtained from 18 nests in 1976 and 17 nests in 1977. Assuming an incubation period of 35 days (Olendorff 1973), the median dates of egg-laying were 21 April 1976 and 19 April 1977. Estimated earliest egg-laying dates were 13 April 1976 and 15 April 1977; latest laying dates were 28 April 1976 and 22 April 1977. Earliest observed hatching dates were 17 May 1976 and 20 May 1977. Latest hatching dates were 1 June 1976 and 27 May 1977. First young were fledged 25 June 1976 and 25 June 1977; latest fledging dates were 12 July 1976 and 10 July 1977.

Ferruginous Hawks in Utah arrived in the nesting area in early March and began laying in late March (Smith and Murphy 1973, Howard 1975). Breeding territories were established at a later date in Harding County, South Dakota than in Colorado (Olendorff 1973) or Utah, but approximately the same time as in north-central South Dakota (Lokemoen and Duebbert 1976).

Nest-sites.—Ferruginous Hawks in Harding County nested on five distinct land surface features: riverbed mounds, river cutbanks, low hills, clay buttes and high vegetated hills. Twenty-one of the active nests (55%) were on clay buttes lacking vegetation. The 35 nests studied were located in unbroken, ungrazed, or lightly grazed prairie or badland areas surround-

ed by prairie. In 1976 an additional nest was located in an alfalfa field. Although Ferruginous Hawks often nest in trees (Olendorff 1973), no active Ferruginous Hawk nests were found in several wooded areas within the study area.

All nests were on the ground. Height of the nest above the surrounding prairie ranged from 0–25 m (mean of 6.1 m in 1976 and 8.6 in 1977). The difference between nest heights for 1976 and 1977 was significant ($t = 1.86$, $df = 34$, $P < 0.05$). Selection of ground nesting sites might be influenced by preference for exposed nest-sites. All nest-sites in Harding County enabled birds to view a large area surrounding the nest. Nests situated at high vantage points might allow adults to detect both potential predators and prey from the nest. Judging from the difficulty we had in climbing to them, most nest were relatively secure from ground predators.

Thirty of the 35 nests were located within a strip 25 km wide extending from northwest to southeast through the center of the county. This band corresponded roughly with the greatest concentration of buttes and hills, and composed approximately 35% of the study area. Land use in the northeast portion of the county was dominated by small grain farming which rendered many areas unsuitable for nesting Ferruginous Hawks. In southwestern Harding County, the land surface features most frequently selected as nest-sites were lacking.

Eight of 17 nests used in 1977 were located within 1 km of a nest active in 1976; four of these were on sites used the previous year. Smith and Murphy (1973) reported that Ferruginous Hawks reoccupied the same nest-site for as many as 4 consecutive years.

Nests were constructed primarily from dead vegetation. The outer basal portion of each nest consisted mainly of sagebrush branches up to 2.5 cm in diameter. Barbed wire, baling wire, twine, paper, plastic and dried cow manure were found in a number of nests. Most nest-cups were lined with buffalo grass (*Buchloe dactyloides*) and a few pieces of paper and dried manure. Nest size averaged 31 cm high, 121 cm across and 58 cm in nest-cup diameter.

Productivity.—Seventy-two percent of 18 nesting attempts were successful in 1976; 82% of 17 attempts were successful in 1977. Hatching and fledging success are shown in Table 1.

One of five nest failures in 1976 occurred when adults abandoned the nest about 25 days after incubation began. Mammalian predators were responsible for three of the five nest failures in 1976 and one of three failures in 1977. Eight of 11 unhatched eggs were infertile.

In two broods the youngest bird disappeared at about 14 days of age. The first nestling that disappeared weighed 55 g at hatching; its nest mates at that time weighed 75 g, 127 g and 155 g. Two days before it disappeared,

TABLE 1
HATCHING AND FLEDGING SUCCESS OF FERRUGINOUS HAWKS IN HARDING COUNTY DURING
1976 AND 1977

Year	Eggs laid	Eggs hatched		Young fledged		Cause of nestling mortality							
						Starvation ^a		Predation		Abandoned		Unknown	
		N	%	N	%	N	%	N	%	N	%	N	%
1976	59	52	(88)	34	(59)	3	(5)	12	(20)	3	(5)	0	—
1977	56	52	(93)	39	(70)	0	—	5	(9)	0	—	8	(14)
Total	115	104	(90)	73	(64)	3	(3)	17	(15)	3	(3)	8	(7)

^a Possibly due to starvation, sibling competition, physical defects, or disease.

this bird weighed 195 g, while its siblings weighed 380 g, 402 g and 465 g. In the second instance, the nestling weighed 413 g the day before it disappeared; its nest mates weighed 558 g, 573 g and 694 g. Most likely the youngest birds were either killed and eaten by the larger nestlings or died and were then consumed. Ingram (1959) reported that fratricide occurs frequently among buteos.

The four nests destroyed by predators were located on low (<5 m) hills or clay buttes. All of these sites were easily climbed during nest checks. Fresh fox scats were found at three of the four nests, implicating the red fox (*Vulpes fulva*) as the responsible predator. Coyote (*Canis latrans*) scats were found at the fourth nest. No renesting attempts were made during the study.

Plumage type.—Birds of two distinct plumage types were seen on the study area. Of 84 adults, two (2.5%) were dark phase birds and 82 (97.5%) were light phase. This is similar to 3% dark phase birds in Colorado (Olen-dorff 1973) and 3.5% dark phase birds in Utah and Idaho (Howard 1975).

Diet during the breeding season.—Three hundred forty-two pellets and individual remains of prey animals were collected from 18 nest-sites in 1976, and 348 from 17 nest-sites in 1977. Mammals composed 70% of the prey items, birds 27% and reptiles 3% (Table 2). Remains of thirteen-lined ground squirrels, Western Meadowlarks and white-tailed jackrabbits occurred most frequently in pellets. Eighty-two percent of Western Meadowlarks identified from pellets and prey remains were juveniles. Cameron (1914) and Angell (1969) found that birds taken as prey were primarily recently fledged individuals. Black-tailed jackrabbits were the major food item of Ferruginous Hawks in Utah (Weston 1969, Smith and Murphy 1973). Ground squirrels were most important in Colorado (Olen-dorff 1973) and South Dakota (Lokemoen and Duebbert 1976). Woffinden and Murphy

TABLE 2
NUMBER AND PERCENT OF PREY TYPES IN THE DIET OF FERRUGINOUS HAWKS IN 1976
AND 1977

Species	1976		1977		Both years combined	
	N	%	N	%	N	%
Mammals						
Thirteen-lined ground squirrel (<i>Spermophilus tridecemlineatus</i>)	156	(46)	147	(42)	303	(44)
White-tailed jackrabbit (<i>Lepus townsendii</i>)	18	(5)	49	(14)	67	(10)
Northern pocket gopher (<i>Thomomys talpoides</i>)	21	(6)	33	(10)	54	(8)
Eastern cottontail (<i>Sylvilagus floridanus</i>)	4	(1)	9	(3)	13	(2)
Black-tailed prairie dog (<i>Cynomys ludovicianus</i>)	1	tr ^a	6	(2)	7	(1)
Long-tailed weasel (<i>Mustela frenata</i>)	0	(0)	3	(1)	3	tr
Deer mouse (<i>Peromyscus maniculatus</i>)	1	tr	1	tr	2	tr
Ord kangaroo rat (<i>Dipodomys ordi</i>)	1	tr	0	(0)	1	tr
House mouse (<i>Mus musculus</i>)	2	(1)	0	(0)	2	tr
Western harvest mouse (<i>Reithrodontomys megalotis</i>)	2	(1)	0	(0)	2	tr
<i>Peromyscus</i> spp.	3	(1)	0	(0)	3	tr
Hispid pocket mouse (<i>Perognathus hispidus</i>)	16	(5)	5	(1)	21	(3)
Total mammals	229	(66)	256	(73)	485	(70)
Birds						
Western Meadowlark (<i>Sturnella neglecta</i>)	91	(27)	71	(20)	162	(24)
Horned Lark (<i>Eremophila alpestris</i>)	6	(2)	3	(1)	9	(1)
Chestnut-collared Longspur (<i>Calcarius ornatus</i>)	1	tr	0	(0)	1	tr
Gray Partridge (<i>Perdix perdix</i>)	1	tr	0	(0)	1	tr

TABLE 2
CONTINUED

Species	1976		1977		Both years combined	
	N	%	N	%	N	%
Common Flicker (<i>Colaptes auratus</i>)	0	(0)	4	(1)	4	(1)
Sprague's Pipit (<i>Anthus spragueii</i>)	0	(0)	3	(1)	3	tr
Lark Bunting (<i>Calamospiza melanocorys</i>)	2	(1)	2	(1)	4	(1)
Sparrow (unknown spp.)	3	(1)	0	(0)	3	tr
Total birds	104	(31)	83	(24)	187	(27)
Reptiles						
Western hog-nosed snake (<i>Heterodon nasicus</i>)	6	(2)	6	(2)	12	(2)
Gopher snake (<i>Pituophis melanoleucus</i>)	2	(1)	2	(1)	4	(1)
Short-horned lizard (<i>Phrynosoma douglassi</i>)	1	tr	0	(0)	1	tr
Leopard frog (<i>Rana pipiens</i>)	0	(0)	1	tr	1	tr
Total reptiles	9	(3)	9	(3)	18	(3)
Total prey items	342		348		690	

^a Tr = <1%.

(1977) attributed a decline in Ferruginous Hawks in Utah to a decline in jackrabbits.

Juvenile post-fledging activity.—The senior author spent approximately 600 h observing juvenile post-fledging activity. Dependence of fledglings on the nest-site as a feeding station ceased 2 weeks after fledging. By this time the young had apparently developed the flying and hunting coordination necessary to make them somewhat independent, although several remained dependent on adults for food for up to 4 weeks after fledging. Although young birds were observed hunting during this period, no actual prey captures were observed. Young birds roosted on buttes and hills within the hunting range of their parents.

The maximum area covered by the fledged young increased each week

TABLE 3
 MAXIMUM AREA (HA) USED BY RADIO-TAGGED JUVENILE FERRUGINOUS HAWKS AFTER
 FLEDGING IN 1977

Bird	Sex	Nest #	Weeks after fledging			
			1	2	3	4
1	M	1	82	365	773	776
2	F	1	128	316	454	658
3	F	2	20	71	247	502
4	F	2	29	211	377	794
5	F	3	88	9	19	94
6	F	3	13	8	16	105
$\bar{x} \pm SD$			60 ± 46.2	163 ± 156.7	314 ± 287.9	488 ± 318.8

(Table 3). Two weeks after fledging one male and one female from the same nest began using a large hill near the nest for perching and did not return to the nest-site. Two other birds expanded the area which they hunted to include several buttes that provided perching sites the second week after leaving the nest. These buttes had been hunted by their parents. During the next 2 weeks the birds shifted to an area from which wild hay had been cut recently. The round bales of hay provided numerous perches, while the short grass made potential prey readily visible to the young birds. A third duo expanded their range away from human activity; they avoided a heavily used highway and ranch buildings.

Loss of radio and visual contact with the birds generally occurred during the fifth week after fledging. Adult Ferruginous Hawks apparently departed by the first week in September, after having been present on the study area for about 5.5 months.

Probable impact of human activity and development.—Ferruginous Hawks are sensitive to human activity and will readily abandon their nests, even after a single human visit, if the eggs are still unhatched (Snow 1974). Activities in the vicinity of a nest, such as plowing and disking, mineral exploration and extraction, or off-road recreational vehicle use can cause nest abandonment. Such activities occurring repeatedly after the young have hatched may keep the attending adults off the nest for long periods of time. Harding County has extensive mineral resources including oil, gas, uranium and coal. The intensification of agriculture, mineral exploration and development, and increased recreational demands of energy related workers will reduce the number of areas of Harding County which are suitable for nesting Ferruginous Hawks. Since Ferruginous Hawks require areas free from human disturbance for nesting, an increase in

human activity will probably lead to a smaller breeding population of this species in this area.

SUMMARY

The density of Ferruginous Hawk pairs in a 7000 km² study area in northwestern South Dakota was one pair per 292 km² in 1976 and one pair per 412 km² in 1977. Thirteen of 18 nesting attempts were successful in 1976; 14 of 17 attempts were successful in 1977. Successful nests were located in unbroken, ungrazed, or lightly grazed prairie. All nest-sites were on the ground surface on riverbed mounds, river cutbanks, low hills, clay buttes, or high vegetated hills. Prey consisted primarily of thirteen-lined ground squirrels, Western Meadowlarks and white-tailed jackrabbits. Young birds returned to the nest to obtain food from the adults and to roost for 2 weeks after fledging; they left the study area during the fifth week after fledging.

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